

# Transponders and Corners **DLR's Next Generation SAR Calibration Targets**

Björn Döring, Marco Schwerdt  
CEOS 2013, Montreal



Knowledge for Tomorrow



# South Germany DLR Calibration Field

Permanent installation:

- 4 trihedrals (1.5 m) in N Germany





# South Germany DLR Calibration Field



Permanent installation:

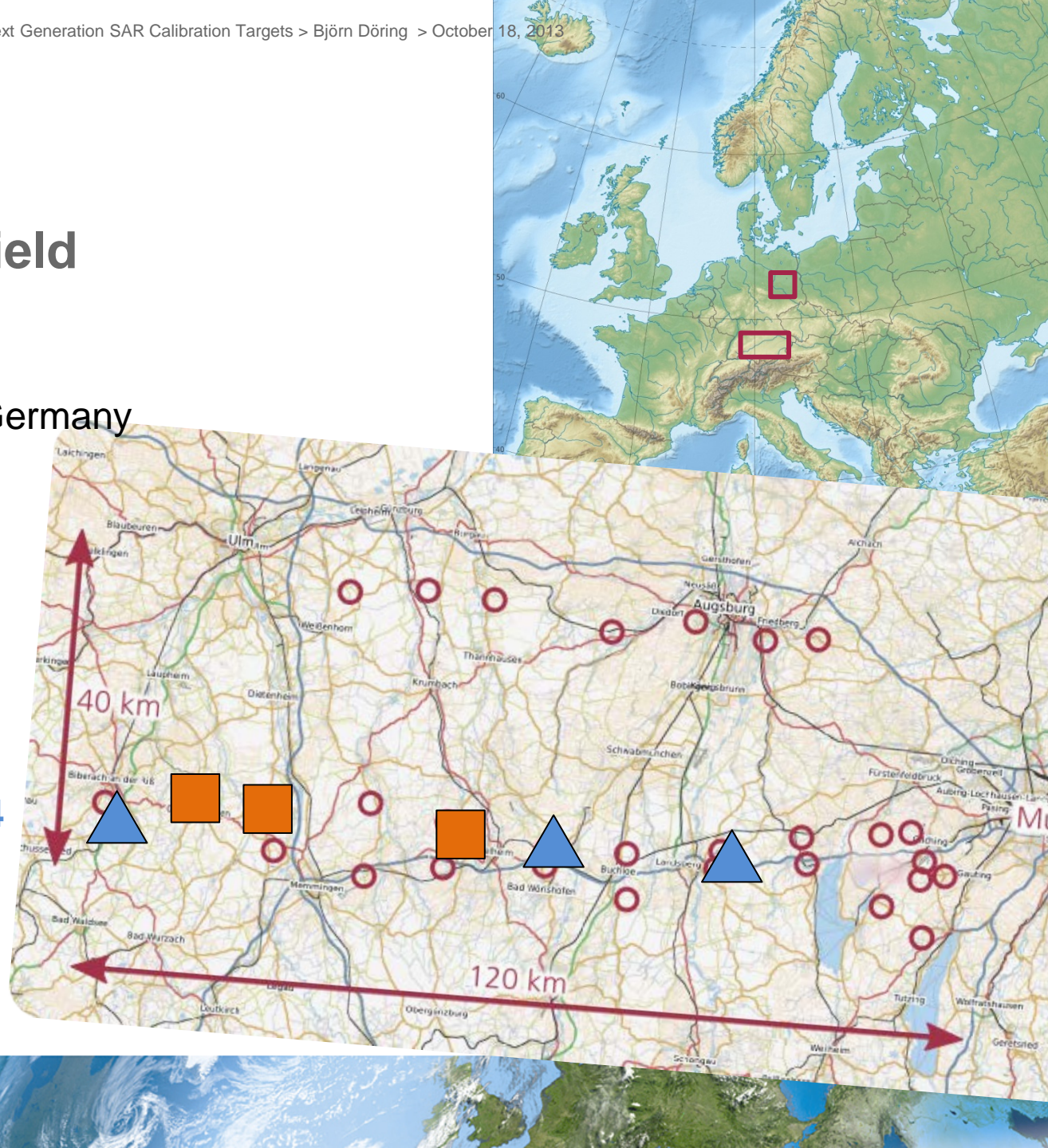
4 trihedrals (1.5 m) in N Germany

Stand-by calibration field  
(S Germany):

- 24 trihedrals (1.5 m)
- 6 trihedrals (3.0 m)

**New installation 2013/14**

-  3 trihedrals (2.8 m)
-  3 C-band transponders (60 dBm<sup>2</sup>)





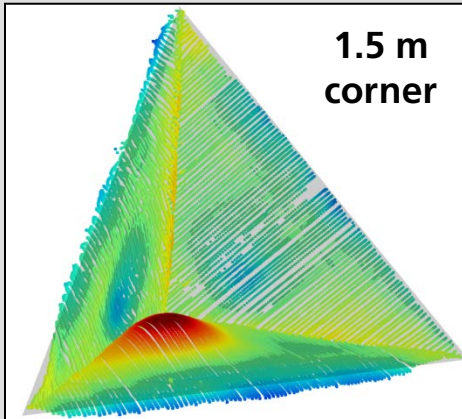
# Remotely Controlled 2.8 m Trihedrals

- Corners are remotely controlled
- Realignment per overpass/mission
- Design allows parking position (better protection)
- Low mechanical tolerances ( $< 1 \text{ mm}$ ), verified by laser measurements

+ 3mm

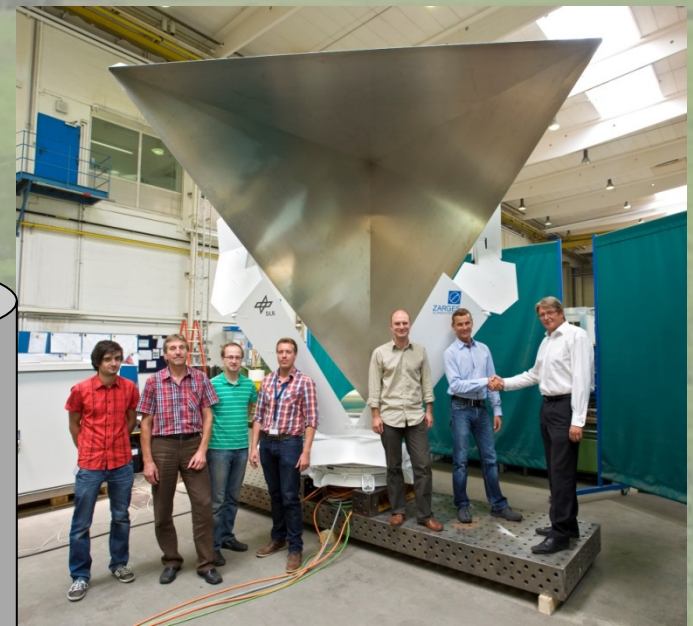
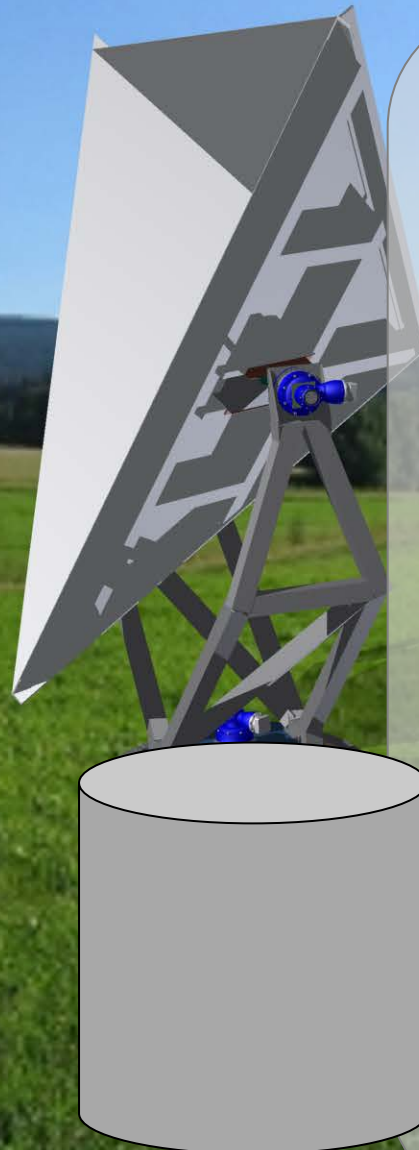


- 3mm



1.5 m  
corner

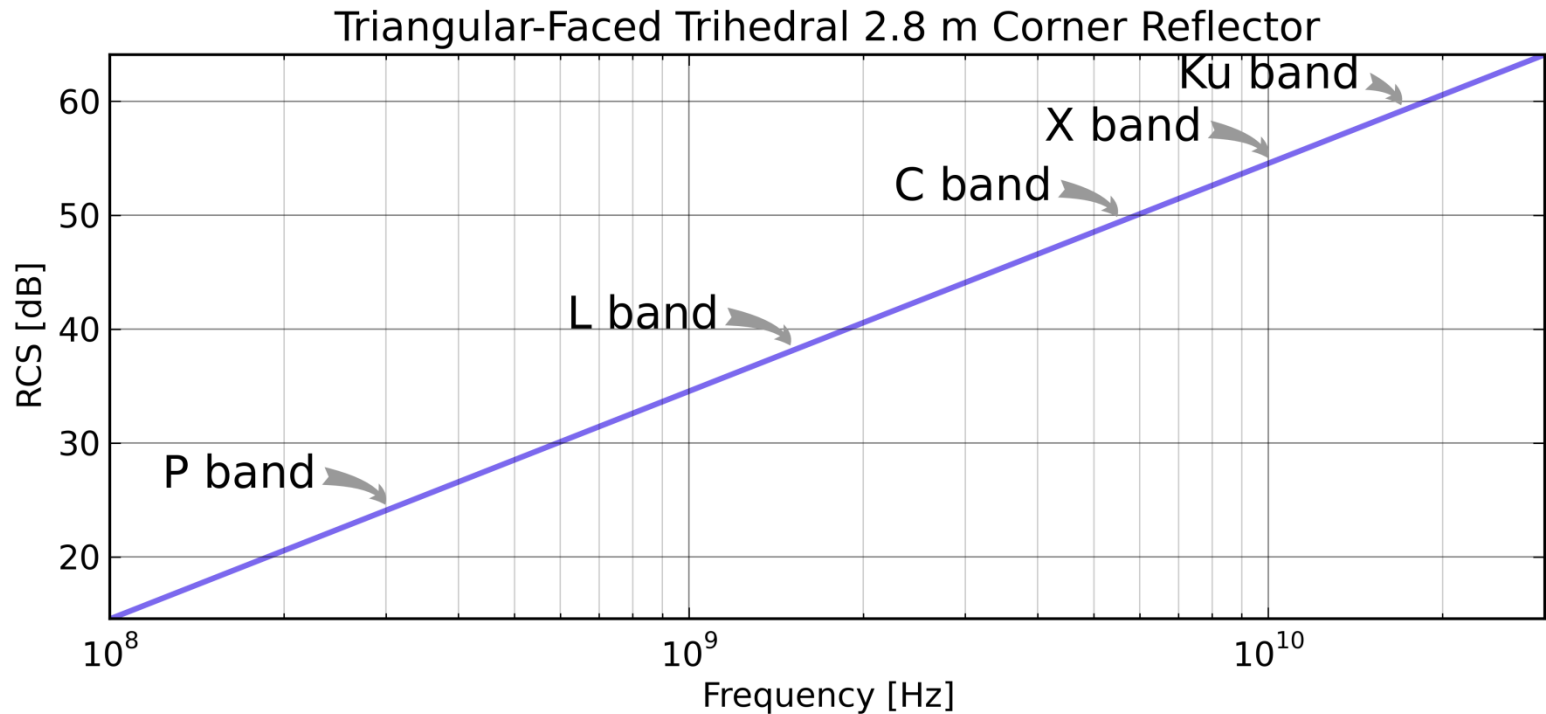
- Considerable foundation (geometric calibration!)
- Foreseen lifetime:  $> 15$  years
- Installation: 2013



*FAT in July 2013*

*Proof-of-concept measurements*

## 2.8 m Corners Compatible with all Known Missions

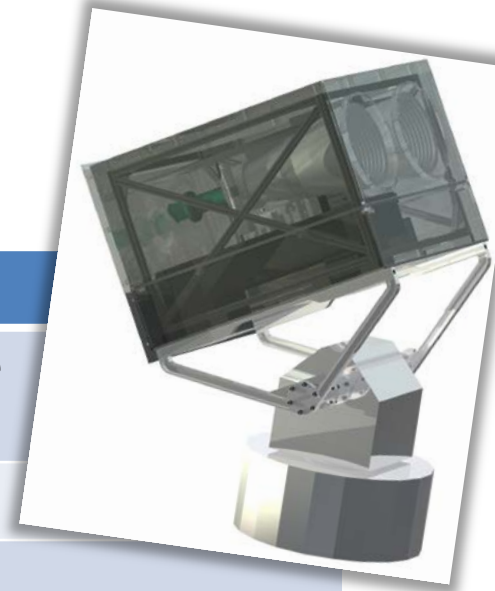


**Corners are good candidates for cross-calibrations as well as for accurate, long-term geometric and radiometric monitoring**



# Kalibri Transponders

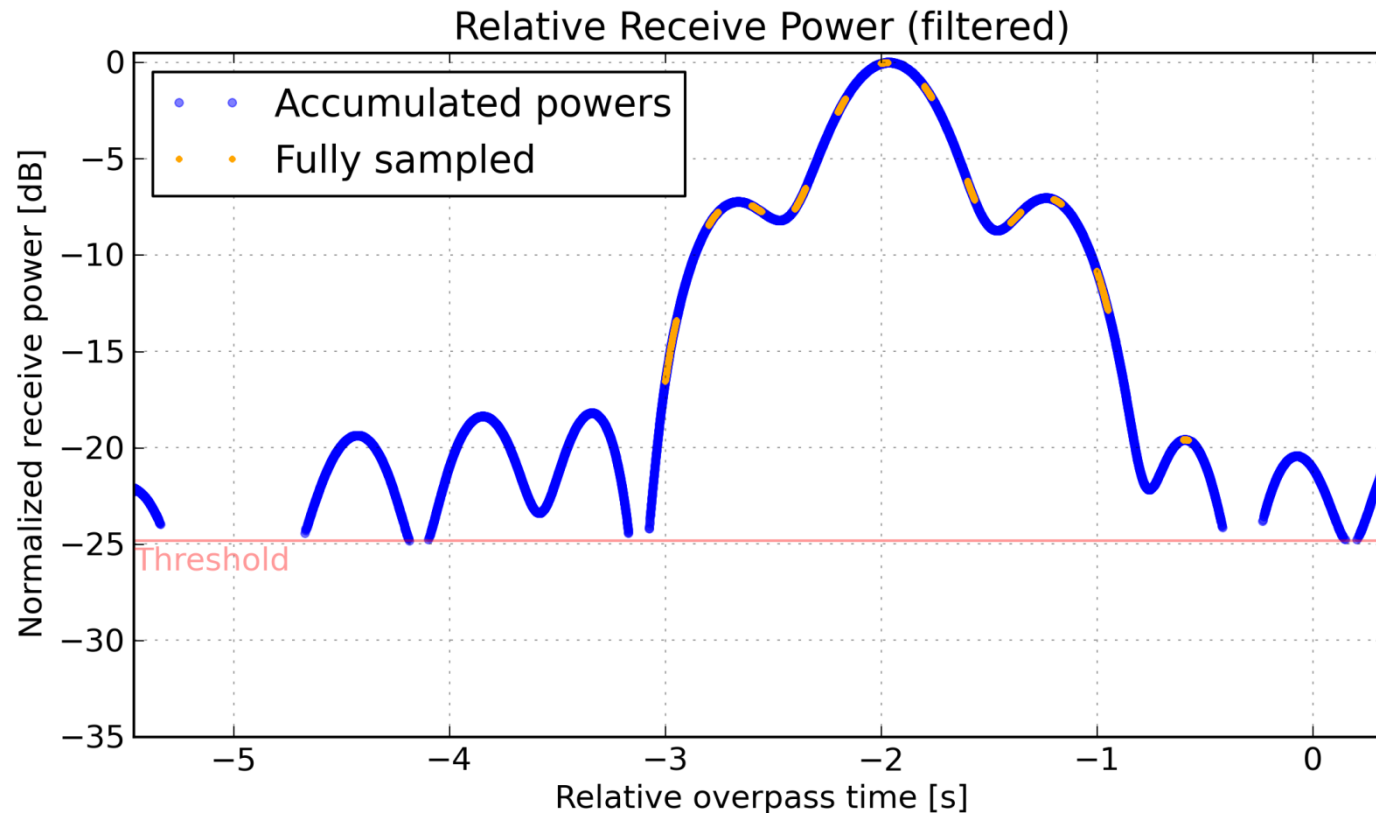
	C-band	X-band
Devices	1 prototype 3 production devices	1 prototype
Center frequency	5.405 GHz	9.650 GHz
Bandwidth	100 MHz	600 MHz



- RCS: 60 dB
- Modular design (C and X band)
- Adjustable TX/RX polarization (antennas motorized)
- Pulse recording (coherent & pulse powers) with GPS time tags (timing uncert. 150 ns)
- High gain stability (0.01 dB)
- Gain monitoring implemented
- Mounted on positioner (parking position supported)
- Autonomous operation
- Remote configuration
- Extensive external calibration efforts (RCS std. uncert. 0.2 dB)

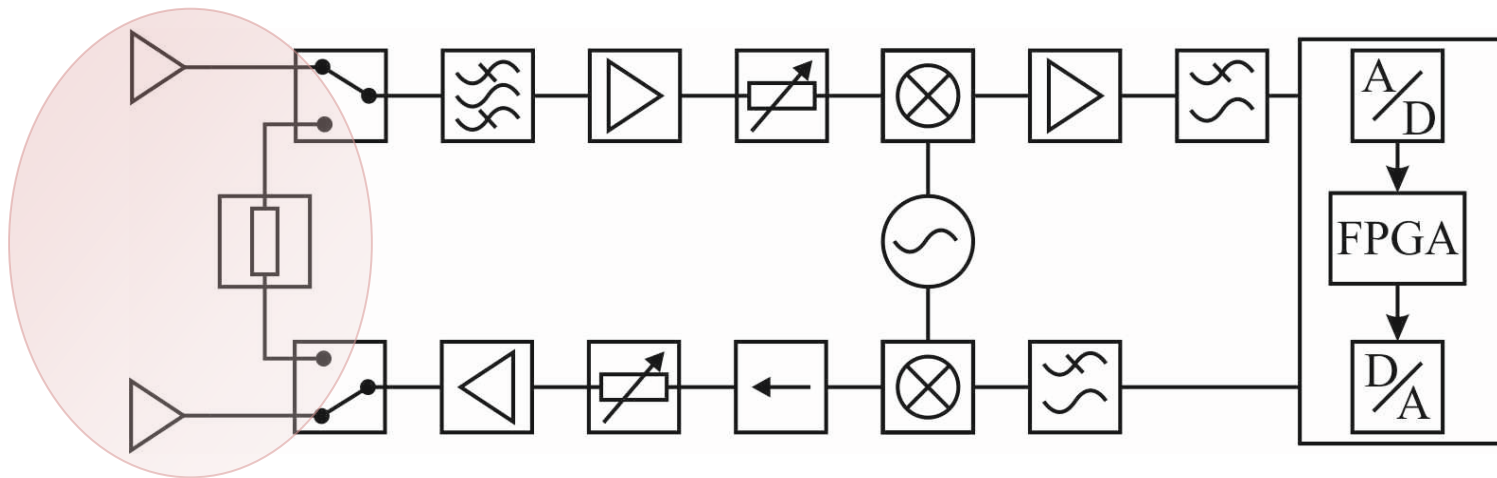


# Pulse Power & Coherent Pulse Recordings



Transponder:	Kalibri2
Conf. center time:	2013-04-14T17:07:47.572593 UTC (= 0 s)
Rel. time at maximum:	-1.964291 s
Max. digital RMS amplitude:	246.2
Pulse count (full):	7939 (823)

## High RCS Stability (std. uncert. 0.01 dB)

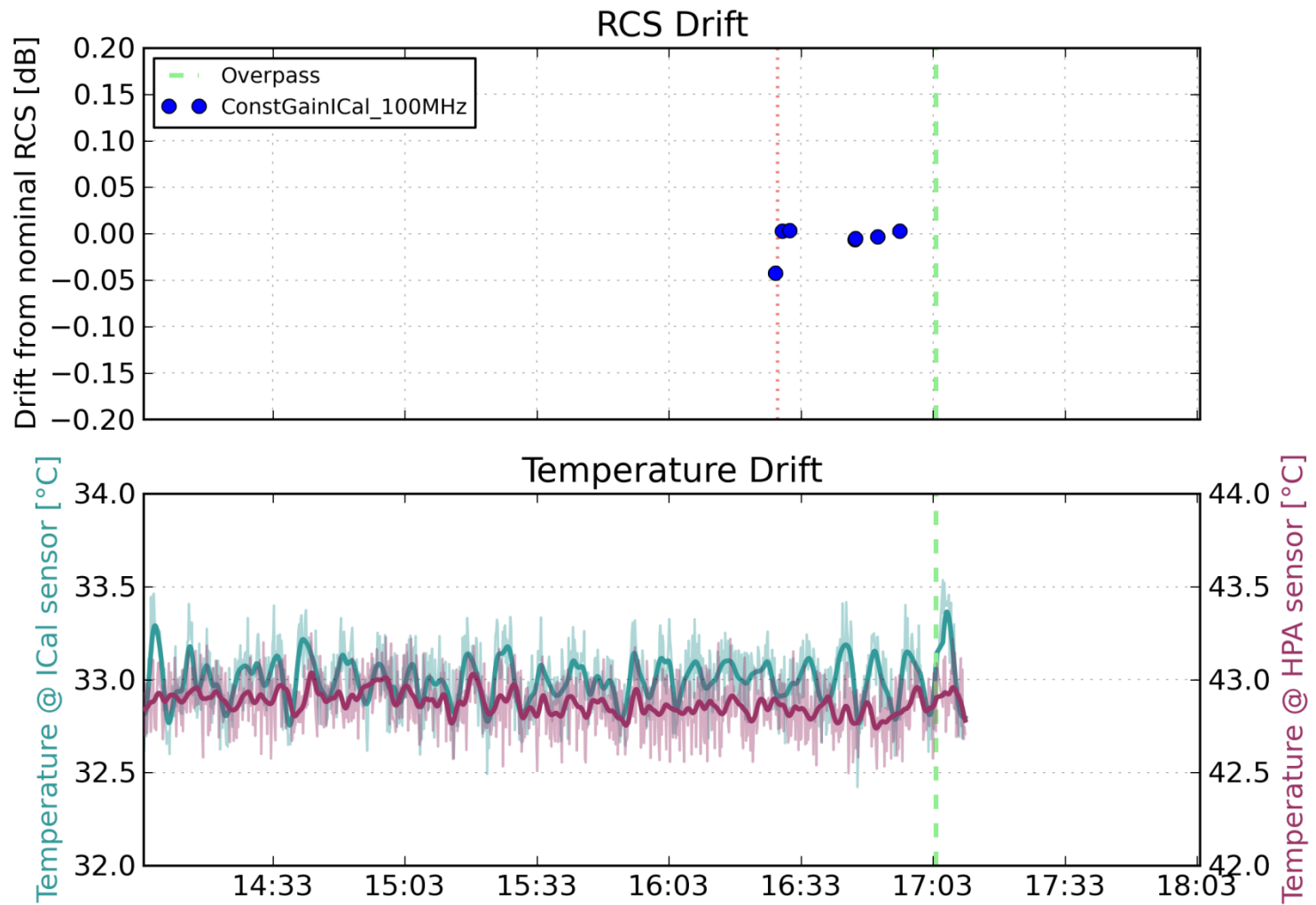


- Minimal number of parts outside internal calibration loop
- FPGA allows fine gain (i.e. RCS) adjustments ( $< 0.01$  dB)



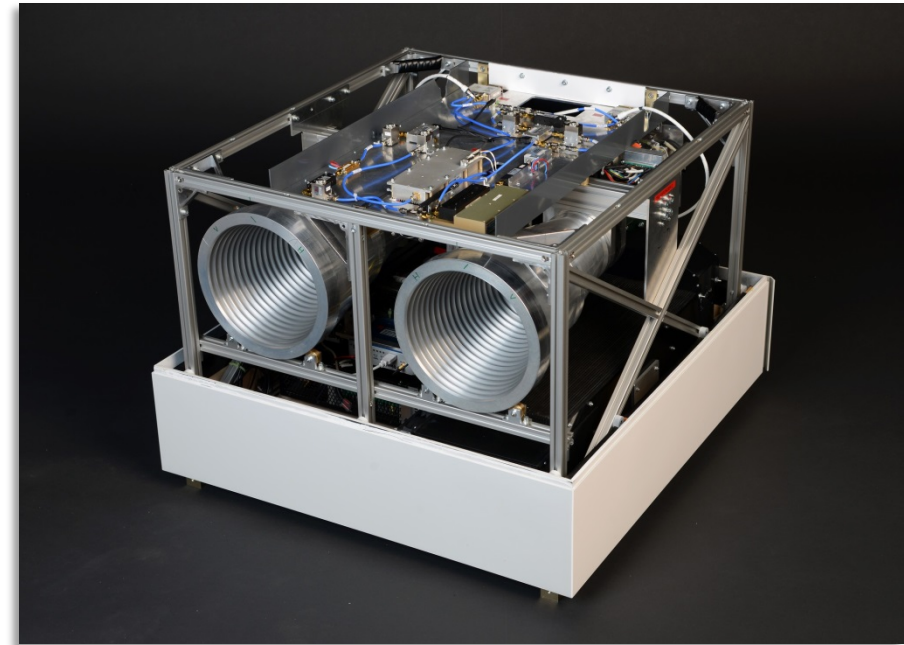


# High RCS Stability (std. uncert. 0.01 dB)



## Further Transponder Features

- Corrugated horns designed and fabricated in-house
- High x-pol isolation ( $> 45$  dB)
- High decoupling allows simultaneous TX/RX
- Settable delay (modify range position)
- Temperature controlled housing (custom heat exchanger)



*Production device for Sentinel-1 campaign*



# Transponder RCS Calibration

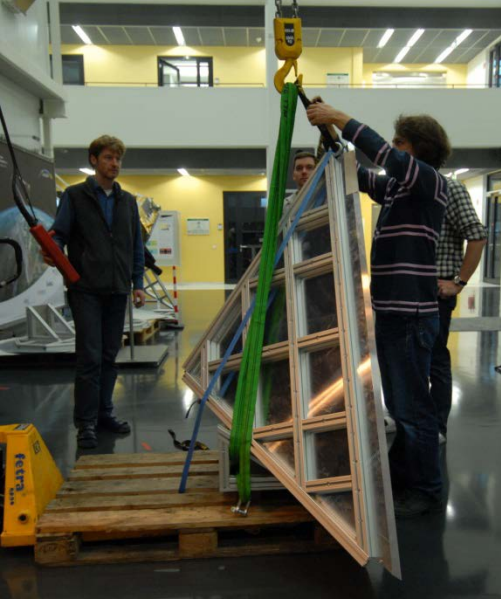
- Absolute calibration accuracy unprovable
- Plausibility checks necessary
- Several independent transponder calibration campaigns performed/planned:
  - DLR outdoor measurement range
  - DLR compact test range
  - RADARSAT-2 campaign
  - (novel method being tested)



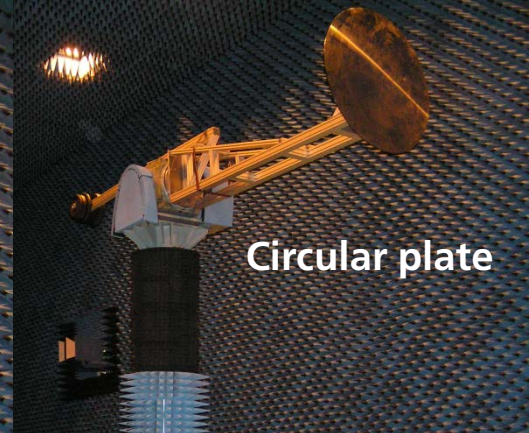
*Outdoor measurements*



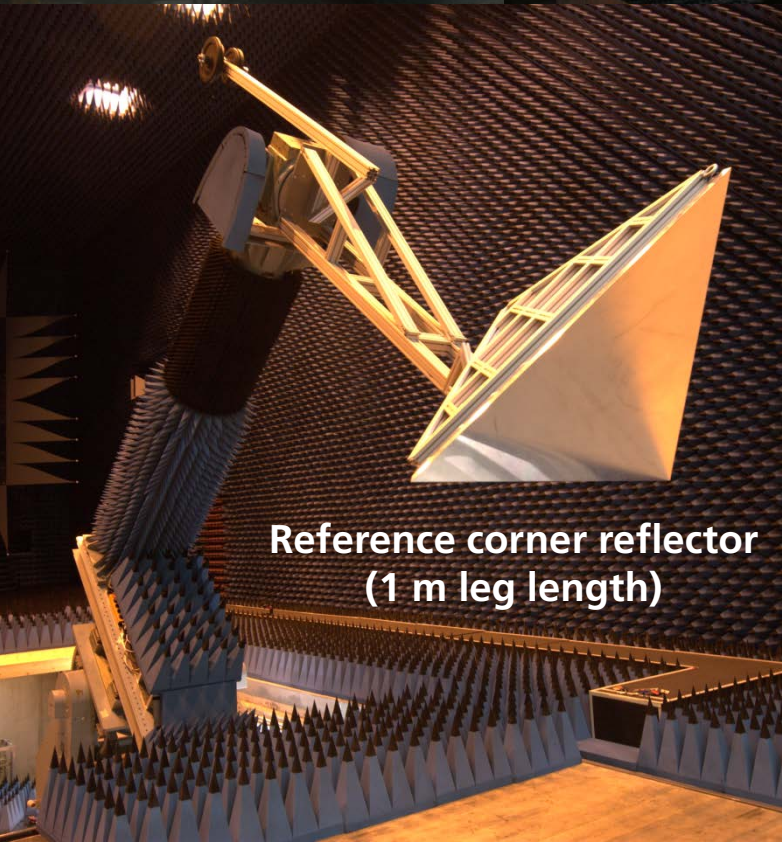




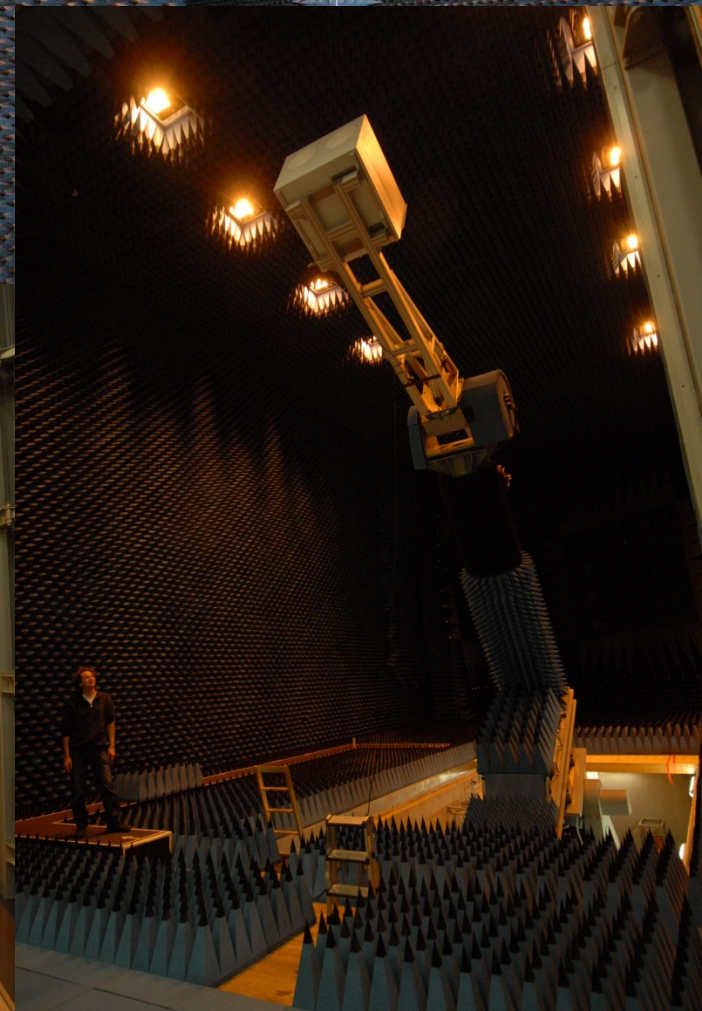
## DLR Compact Test Range



Circular plate



Reference corner reflector  
(1 m leg length)





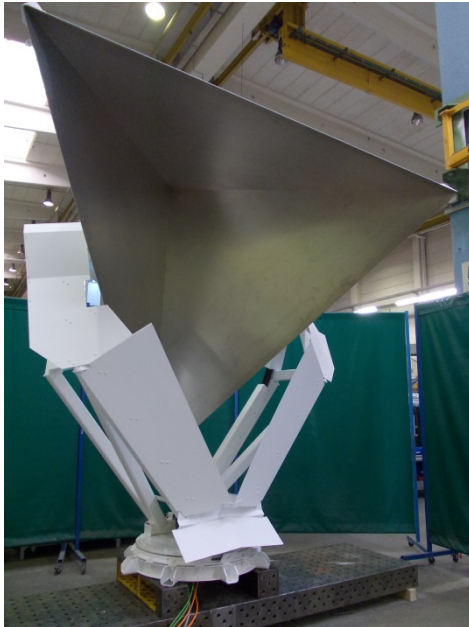
# First RADARSAT-2 Image of Kalibri Prototype

April 2013

- 15 reference corners deployed around Oberpfaffenhofen
- 8 overpasses
- Many thanks to MDA for providing the data!



# Conclusions



## 3 New 2.8 m Reference Corner Reflectors

- Accurate
- Remote controlled
- Built to last

## 3 New C-Band Transponders

- Polarimetric
  - Stable
  - Accurate

